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ABSTRACT

A cross-modal priming experiment was conducted to test the hypothesis that lexical access of verbs marked with a specific inflectional suffix would be facilitated by immediately prior exposure to semantically and contextually unrelated verbs with the same suffix. It was hypothesized that while listening to spoken "-ed" sentences, subjects would respond more quickly to target words in the "-ed" form than in the "-s" or bare root form. Subjects were 15 university students, all native speakers of English, who responded to 60 visually presented target words, all based on one-syllable verb roots, while listening to aurally presented sentences of two types, one with and one without "-ed" verb morphology to provide a past tense environment. The predicted priming did not occur. Instead, bare root forms showed an absolute advantage over inflected forms in this experimental paradigm. However, an unanticipated finding was that responses to inflected forms were affected by the kind of discourse that was being attended to auditorily at the time of the visual lexical decision. There was no such effect of discourse context on responses on uninflected verbs. Results lend some support to the view that inflection triggers discourse integration. Contains 37 references. (MSE)

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A Search for Inflectional Priming Reveals an Effect of Discourse Type on the Lexical Access of Inflected Verbs*

Greg Thomson and Bushra Adnan Zawaydeh

A cross-modal priming experiment was conducted to test the hypothesis that lexical access of verbs marked with a specific inflectional suffix would be facilitated by immediately prior exposure to semantically and contextually unrelated verbs with the same suffix. Such priming was not detected. Rather it turned out that bare root forms showed an absolute advantage over inflected forms in this experimental paradigm. However, an unanticipated finding appeared: responses to inflected forms were affected by the kind of discourse that was being auditorily attended to at the time of the visual lexical decision. There was no such effect of discourse context on responses to uninflected verbs. The results lend some support to the view that inflection triggers discourse integration.

1. Introduction

1.1. Overview

The research reported here began with a conception of the lexicon in which inflected forms of common words are listed in the lexicon with their inflectional affixes attached (Bybee 1988, 1995). For example, the word *jumped* would be listed in the lexicon with the *-ed* attached. The prediction was that given a pair like *jumped/poked*, there would be priming of the second member (*poked*) by the first (*jumped*). By contrast, in the case of pairs like *jumping/poked*, where the inflection differs, there would be no priming effect.[1] This prediction was based on Bybee's model of the lexicon, according to which all *-ed* inflected verb forms are linked to one another. Rather than test this hypothesis with isolated words, we decided to place the priming words in aurally presented sentences, while presenting the targets visually.

As will be seen, it turned out that our prediction was not supported. However, in the process of testing this prediction, we discovered an unanticipated effect which has more of a bearing on the *function* of inflectional affixes than on the issue of their lexical organization. In what follows, I begin with the consideration of the original hypothesis and its significance. After describing the experiment and the findings I then discuss the new direction in which the results point us. The question regarding inflection in the lexicon remains an important one. However, the findings

* This is based on work originally reported in Thomson 1994 and Zawaydeh 1994. We have received helpful feedback from Jean Newman, Joan Bybee, Daniel Morrow, and Mark Karan.

[1] A word is said to be primed when subjects are able to access it more readily than otherwise. Increased ease of access might be reflected in the speed with which it can be read aloud (the naming latency), the speed with which subjects can decide that it is a real word (the lexical decision latency), the duration for which a word must be presented in order to be recognized (tachistiscopic presentation), or the amount of white noise through which a word can be identified. High frequency words are more readily accessed than low frequency words (frequency priming). Words that are repeated are more readily accessed than words that are presented for the first time (repetition priming). Words preceded by semantically related words are more rapidly accessed than words preceded by semantically unrelated words. In a priming experiment the words which are intended to receive priming are called targets, while the words causing the priming are sometimes called primes.

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here open the possibility of a new line of research into the function of inflectional affixes in language processing, a result which I believe is of some interest in its own right.

1.2. Inflection and the Lexicon in Linguistics and Psycholinguistics

A cursory survey of grammatical descriptions of languages from most parts of the world will reveal the usefulness of inflectional paradigms as a descriptive organizational device. In the case of verbs, most of the inflectional categories fall into a few etic families such as person/number, tense, aspect, and mood. The widespread presence of inflectional morphology in the world's languages may relate in as yet poorly understood ways to fundamental aspects of language processing.

From a theoretical perspective, linguists in the twentieth century have most often treated inflectional morphemes, like affixes generally, as meaningful "pieces" used in the construction of words (e.g., Bloomfield 1933), rather than as parts of lexical entries. In the early days of syntactic theory, it was common to treat structure below the word level as a downward continuation of phrase-style syntax (e.g. Chomsky 1957; Lees 1963). Difficulties quickly arose in this total merger of morphology and syntax (Chomsky 1970). The resulting lexicalist hypothesis allowed words with nonproductive derivational affixes and irregular inflection to be listed in the lexicon with the affixes attached, and also allowed for the expressions of the relatedness of words which shared such affixes. On the other hand, words with regular affixes would not be included in the lexical listing, but would rather result from the operation of rules which combine affixes with stems or rules which "spell out" feature bundles as affixes. These productive rules might operate within the lexicon (particularly if they add derivational affixes), or they might occur at some point during or after syntactic operations (particularly if they add inflectional affixes). Recently there has been some debate about whether the affixes that are added by rules are themselves lexical items (Lieber 1992; Halle and Marantz 1993) or whether they are better viewed as simply involving alterations in the forms of words (Anderson 1992; Beard 1995). Bybee (1988, 1995) is unusual among linguists in maintaining that common regularly inflected words are listed in the lexicon rather than being created through the productive concatenation of lexical "pieces" or by productive spelling rules.

Turning to the study of inflection in psychology we find that it grew out of an interest in word recognition. According to Henderson (1989), this interest in word recognition in turn grew out of a general interest in pattern recognition, rather than out of interest in the mental lexicon or language processing. The early study of inflection by Gibson and Guinet (1971) probably falls in this category. There was subsequently a shift to interest in lexical organization and lexical access as psycholinguistic phenomena. Still, the heritage of word recognition as pattern recognition may have predisposed psycholinguists to be more willing than linguists to treat inflected words as singular perceptual objects.

In fact, the study of speech production, especially by scholars using speech errors as a source of data (Bock & Eberhard 1993; Garrett 1980; MacKay 1979) resulted in models in which regular inflected forms are claimed to be constructed by combining stem and affix on line, consistent in spirit with most linguistic models. The production evidence is not unequivocal however, at least in the view of Butterworth (1983) who broke ranks with Garrett and MacKay on the issue of the psychological productivity of inflectional morphology, arguing that inflected words are accessed intact from the mental lexicon during speech production. Pinker (1991) reports an experiment in which subjects were shown present tense verbs and required to respond

by producing the past forms. For verbs with irregular past forms, the response latencies were affected by the frequency of the irregular item (based on the Francis and Kucera 1982 frequencies of English words). The response latencies for regular past forms were not affected by frequency. Pinker takes this as evidence that regular forms are constructed on-line, while irregular forms are retrieved from memory.

Our concern here is with the comprehension of inflected forms rather than with their production in speech. In contrast with students of language production, students of comprehension have generally acted as though the mental language processor deals in whole inflected words, although an early step in word identification may involve identifying the stem (Feldman & Fowler 1987; Fowler, Napps, & Feldman 1985; Jarvella & Meijers 1983; Lukatela, et al. 1978; Murrell & Morton 1974; Stanners, Neisser, Hernon & Hall 1979; Taft 1979; Laudanna, et al. 1989).

These findings generally suggest that in some sense inflectional variants of a single word are instances of "the same word".[2] This has been demonstrated using a wide range of experimental techniques.[3] In general, the results favor treating inflectional variants of a single stem as instances of the same lexical item.

Most of the above cited studies are studies of English. Exceptions are Jarvella and Meijers 1983 (Dutch) and Laudanna, et al. 1989 (Italian). It could be argued that the most these studies indicate is that it is the stem that is both the priming element and the primed element in inflectionally related pairs such as *walks/walked*. For example, Jarvella and Meijers' (1983) subjects could perform the judgment that two words contained the same stem just as quickly when shown an inflected and an uninflected variant of a single stem as when shown two instances of the identical uninflected stem. The further conclusion that an inflected stem and its uninflected counterpart are in some sense instances of "the same word" may not be warranted on the basis of such evidence.

However, studies by Lukatela and colleagues (Lukatela, Gligorijevic, Kostic, & Turvey 1980; Lukatela, et al. 1978) with Serbo-Croatian speaking subjects led to the proposal that the central member of an inflectional family is not the stem, but rather the base form, which only sometimes turns out to be the bare stem.[4] They found that lexical decision latencies were shortest with the nominative singular forms of nouns (what are considered the base forms). For masculine

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[2]As the terms are used here, a stem is a form which can take inflectional affixes. A stem that is an atomic unit is a root. In general a root need not be a stem, but in the experiment reported here, all stems are roots, that is, they cannot by anyone's reckoning be divided into smaller units other than phonological units. In connection with the literature in general we will speak of inflected stems. In connection with the experiment here, we will generally speak of roots.

[3]The techniques employed included tachistoscopic presentation (Murrell & Morton 1974) lexical decision (Fowler, et al., 1985; Stanners, et al., 1979; Taft 1979), and auditory presentation in the presence of noise (Kemply & Morton, 1982). The evidence supporting the claim that inflectional variants are instances of "the same word" includes frequency priming (Taft, 1979), repetition priming (Fowler, et al., 1985; Kemply & Morton 1982; Murrell & Morton 1974; Stanners, et al., 1979), and same-or-different judgments (Jarvella & Meijers 1983).

[4]An inflectional family is the lemma of words based on inflectional variation of the same stem, such as *kick, kicked, kicks, kicking*. What counts as a base form for a given lexical category will obviously be language specific, but it is an interesting question whether it can be partly or wholly predicted from other language-specific morphological facts along with cross-linguistic principles.

nouns these were the uninflected stems, but nominative feminine nouns are inflected and have the same level of morphological complexity as non-nominative case-marked masculine and feminine nouns.[5] Thus it may be the base status, not the absence of inflection, that facilitates lexical access.[6]

It has been shown that case-inflected nouns sharing a common base in Serbo-Croatian cause significant facilitation of one another in a lexical decision task. However, this priming effect is much smaller than the bidirectional priming between base forms and other forms. Feldman and Fowler 1987 take this as evidence for the satellite model proposed by Lukatela et al. (1980). In this model of the mental lexicon, inflectional families (sometimes referred to as *lemmas*) are connected in a manner suggested by Figure 1, with the base form in the center, and other forms attached to it as satellites.

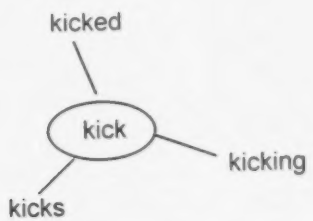

Figure 1. Satellite model of lexical representation

The fact that the amount of priming of one non-base form by another is less than the amount of priming between a base form and a non-base form is thus explained by the claim that the link between separate non-base forms is indirect, mediated by the base, while the connection between base and non-base forms is direct.

The satellite model deals with the special status of the base, but says little about the role of inflectional affixes in processing. Günther (1988) found evidence for a base bias in lexical decisions which disappeared in the presence of syntactic priming (i.e., where the target word occurred in a syntactic context which required either a base or non-base form). Similar findings were previously reported for English by Tyler and Marslen-Wilson (1986). Günther proposed that the satellite model be replaced with a model in which a lemma of inflectional variants including the base form contains a pointer which must be set to choose the form required by a given syntactic context. The special status of the base form derives from its being the default

[5]Actually the latencies for the feminine nominatives were shorter than for the masculine ones. The authors suggest this may result from the fact that the masculine stems tend to be longer. It may also be that the presence of an inflection makes it easier to judge the word to be a word. Taft 1976 found that the presence of an inflectional affix made it harder for subjects to reject a non-word in a lexical decision task than to reject uninflected non-words.

[6]The base form would typically be the most frequent form, the one learned earliest, and the form used to "name" a word, as when giving a word list.

form. That is, the pointer is preset to the base form and must be reset by the syntactic context as required to point to a different form.

Günther's pointers may be an unnecessary innovation. Bybee's (1988, 1996) network model of the lexicon appears to raise the possibility of accomplishing the same ends by means of the independently motivated concept of spreading activation (Collins & Loftus 1975; Dell 1986). Bybee's model, which she relates explicitly to the satellite model (Lukatela, et al., 1980) can be considered a refinement of that model. Although her model also assigns primacy to the base form, it attempts to deal with the role of affixes as well as stems. In Bybee's model, instances of the same affix, like instances of the same stem, are linked in the lexicon in a manner suggested by Figure 2.

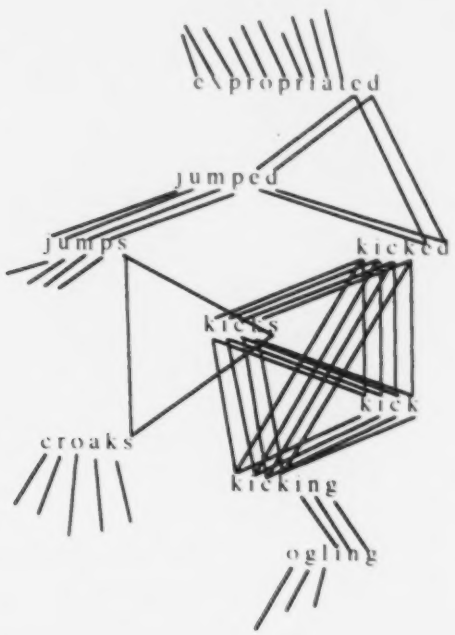

Figure 2. "Morphology as lexical representation" model

One of Bybee's arguments is that children learning a language must first learn a number of instances of words with a given inflection before the generalization can be made equating those instances with one another and relating them to their semantic content. This generalizing from specific instances of a given inflection based on commonalties of form and meaning is achieved in Bybee's model through the setting up of links between the separate instances of the same inflectional affix. These include semantic and phonological connections.

Bybee's model raises the possibility that a network of words containing a particular inflectional affix might be slightly activated at any given moment during language processing (say, by syntactic or discourse context). In production, the semantic content of an intended message (say, a message about someone *poking* someone) would send activation to all

inflectional variants of a particular stem (*poke, poked, pokes, poking*). But since the desired inflectional variant (let's say, *poked*) would already be slightly activated due to its membership in the currently active network of like-inflected verbs (in this case, all *-ed* inflected verbs), it would reach threshold before the other variants and thus be selected. During language comprehension, if the inflection is marked by a suffix, the model could be held to predict that the inflected form with the appropriate suffix will be primed, so that the suffix would be anticipated as soon as the stem is identified. In fact, Tyler and Marslen-Wilson (1986) have demonstrated this to be the case through auditory gating.[7]

The present experiment was designed to test whether an English verb with a specific inflectional suffix would show a priming effect on other verbs with the same suffix. The question was whether, for example, *kicked* in Figure 2 would prime *jumped* (in contrast with *jumps*). Such a finding could be taken as support for Bybee's model, with spreading activation. The priming effect might be difficult to detect however. Presumably the contribution of the suffix to the activation of the word would be small when compared with the contribution of the stem. Otherwise, as pointed out by Jean Newman (p.c., 1993) the massive network of activated suffixes could lead to frequent activation errors.

The following experiment was aimed at detecting priming of inflected stems by other stems with the same inflection. The detection of such priming would support Bybee's model of the lexicon over the satellite model. It would not in general support a purely concatenative view of inflectional affixes, since detectable priming would suggest that the entire word was facilitated, not just the suffix, given the short time course of word identification and the extremely brief duration of the -ed suffix. The predicted finding might however support a process theory of inflection (e.g., Anderson 1992), since the process of dealing with a particular inflection (whether in comprehension or production) might conceivably be susceptible to priming effects.[8]

2. Method

2.1. Subjects

Fifteen undergraduate students at the University of New Mexico participated as volunteers in the experiment. All but one received extra credit in an introductory linguistics course as a result of participating and preparing a one-page write-up of the experience. There were twelve female and three male subjects, all of whom were native speakers of English.

2.2. Materials

The experiment employed a cross-modal lexical decision technique: while listening to *aurally presented sentences* which contained the priming words, subjects responded to *visually presented target words*. Since the spoken sentences were intended to prime the visual targets, I refer to them at times as *priming sentences* without prejudice as to whether or not they actually achieve any priming of the target words.

The sixty spoken sentences were of two types. In the first type, called here *-ed sentences*, there was a conjunction of three past tense verb phrases in which the verbs had regular *-ed* morphology, such as *The doctor delivered the baby, paddled its behind and listened to it holler.*

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[7]Auditory gating involves presenting the initial portion of words to subjects and determining the point in the word at they are able to guess the entire word the portion they have heard.

[8]However, models like Anderson's are models of competence, not of performance.

The visual target word was presented to the subject simultaneously with the offset of the third *-ed*. It was felt that if any priming were to occur due to the suffix, it would best be detected immediately following the third instance. There were thirty spoken sentences of this type.

The second type of spoken sentence, referred to here as *past progressive sentences*, provided a strong past tense environment, but without the *-ed* morphology. An example is *Just before dawn, the soldiers were nervously guarding the entrance to the palace*. Each of these sentences began with a time adverbial such as *just before dawn*, and contained a single main verb in the past progressive form. In normal discourse, such sentences commonly create a context to be followed by a subsequent sentence with a simple past tense verb. If the *-ed* sentences were to succeed in priming the *-ed* inflected targets, it was hoped that the past progressive sentences would help to determine whether the priming was due to the specific commonality of *-ed* morphology, or whether it might be attributed to the semantic effect of a past tense context. That is, the past progressive sentences provided a semantic past tense environment without the specific *-ed* morphology. There were thirty spoken sentences of this type as well. The placement of the visually presented target word in relation to the past progressive priming sentence was based on its placement in the *-ed* sentences. With the *-ed* sentences, the position of the target was automatically determined by the location of the third *-ed* inflected verb. The visual target word in such cases turned out to be an average of 2.5 syllables from the end of the sentence. Therefore the visual target words that were presented with the spoken past progressive sentences were placed an average of 2.5 syllables prior to the end of the sentences. It was hoped that any effect of sentence wrap-up processing would then be the same in both cases, since the presentation of the target word did in general overlap with the end of the sentence.

The sixty target words were based on one-syllable verb roots. One third had the *-ed* suffix (e.g., *jumped*), one third had the third person singular *-s* agreement suffix (e.g. *jumps*), and one third had the bare stem (e.g., *jump*). These three groups of target words were balanced for lemmatic frequency based on Francis and Kucera (1982) and for orthographic length of the root.[9] A serious effort was made to avoid any obvious semantic relationship between a visual target word and the spoken priming sentence during which it was presented. (Subjects were informed that the word appearing on the screen would be unrelated to the sentence they were listening to.)

Thirty additional spoken sentences were used in combination with non-words for the sake of the lexical decision task. These included fifteen *-ed* sentences and fifteen past progressive sentences. A fourth set of thirty spoken sentences served as fillers. These each contained a modal auxiliary, so that no tense morphology would be involved. The visual probes presented during the spoken filler sentences consisted of ten non-words and twenty nouns.

There was thus a 2 x 3 design: two priming sentence conditions (*-ed* sentences vs. past progressive sentences) by three target word conditions (*-ed* suffix vs. *-s* suffix vs. bare root). No verb root was used twice either within or across the two factors. Both factors were within-subjects, with all fifteen subjects receiving the same stimuli. However, the 120 trials (of which only 60 involved real target words in the relevant priming contexts) were divided into two blocks which were fully matched in terms of the number of stimuli of each type. The order of the sixty trials in each block was then pseudorandomized.[10] Eight of the subjects were presented with the two blocks in one order and seven were presented with the two blocks in the opposite order.

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[9]Lemmatic frequency refers to the frequency of all inflected variants of a word combined.

[10]That is, a random number generator was used to determine the order of presentation, but adjustments were made to avoid sequences of three consecutive stimuli of the same type.

The digitized sentences were presented through headphones connected to an IBM XT computer, and the visual target words appeared on the screen of the same computer.

2.3. Procedure

Subjects were seated directly facing the computer screen. They were instructed to pay attention to the sentence which they heard through the headphones. In order to assist the subjects in attending to the sentences, comprehension questions were included with one in three sentences (preceded by a pause for the lexical decision response). These questions were presented visually on the computer screen and subjects responded orally. The pseudorandomization of the order of the stimuli meant that the subject could not predict in advance which stimuli would be followed by comprehension questions.

At the appropriate point during each spoken sentence the target word or non-word probe would appear on the computer screen. The subject would indicate whether the probe was a word or non-word by pushing a "yes" button or a "no" button respectively. As noted, subjects were instructed that the word appearing on the screen would be unrelated to the sentence they were listening to.

2.4. Results

It was observed that one subject delayed an abnormally long period before every response, and later commented that she was having difficulty concentrating. In all of the six conditions (two priming sentences types by three verb inflection types) this subject's means were more than three standard deviations greater than the group mean. Therefore this subject was omitted from the analysis, leaving fourteen subjects. For each remaining subject the mean reaction time for each of the six conditions was calculated and used as that subject's score for the condition. Generally this was based on ten trials for each condition, though response times were not included when the response was incorrect. (This affected only 3% of the trials.)

The basic descriptive statistics for the six conditions are shown in Table 1. A two-way within-subjects analysis of variance was performed.[11] The results are presented in Table 2.

[11]Analysis of Variance, or ANOVA, is a statistical test used to compare means. The mean reaction times for the various conditions are shown in Table 1. ANOVA was used to determine which of those differences are statistically significant. Differences in mean reaction times are considered significant when the value in the p (probability) column is smaller than 0.05. This indicates that there is less than a 5% probability of the difference being the result of mere chance. Readers lacking statistical background can ignore Tables 1 and 2, as the significant differences are discussed in the text.

Priming sentence	-ed sentence			past progressive		
Target word form	root+*ed*	root+*s*	bare root	root+*ed*	root+*s*	bare root
Mean (in milliseconds):	830.4	856.2	730.5	796.2	789.8	745.7
Std. Deviation:	156.2	140.6	124.8	154.1	133.5	85.6
Variance:	24399.4	19759.3	15573.9	23756.1	17816.4	7335.7
Minimum:	631.2	725.4	566.4	605.5	613.5	636.3
Maximum:	1175.4	1283.8	946.5	1216.1	1064.5	948.3

Table 1. Descriptive statistics for the six experimental conditions

(Means are from 14 subjects, where each subject's score for each condition is itself a mean based on up to ten trials.)

Source	df	Sum of Squares	Mean Square	F-Value	P-Value
Subject	13	1099009.41	84539.18		
Priming Sentence	1	17005.99	17005.98	5.64	.0336
Priming Sententence x Subject	13	39197.97	3015.22		
Target Form	2	120831.21	60415.60	8.52	.0014
Target Form x Subject	26	184213.57	7085.13		
Priming Sentence x Target Form	2	23672.67	11836.33	3.42	.0479
Priming Sentence x Target Form x Subject	26	89908.96	3458.04		

Table 2. Analysis of variance for mean response times in two sentence priming conditions (within-subject) by three target word conditions (within-subjects)

Significant main effects were found for both the priming sentence type (*ed* sentence vs. past progressive) [$F(1,13) = 5.640$, $MSe = 3015.22$, $p < .05$] and for the target word form (*-ed* vs. *-s* vs. bare root) [$F(2,26) = 8.52$, $MSe = 7085.13$, $p < .01$].[12] In addition there was a significant interaction between these two factors (priming sentence type and target word inflectional form) [$F(2,26) = 3.42$, $MSe = 3458$, $p < .05$]. The interaction plot is shown in Figure 3.[13]

[12]In brief, this amounts to saying first, that subjects took longer to respond when listening to *-ed* sentences than when listening to progressive sentences, and second, that subjects responded faster to some verb forms than others (in particular, they responded more quickly to uninflected verbs than to inflected ones).

[13]In short, the response time to inflected verbs was affected by the type of priming sentence, while the response time to bare roots was not.

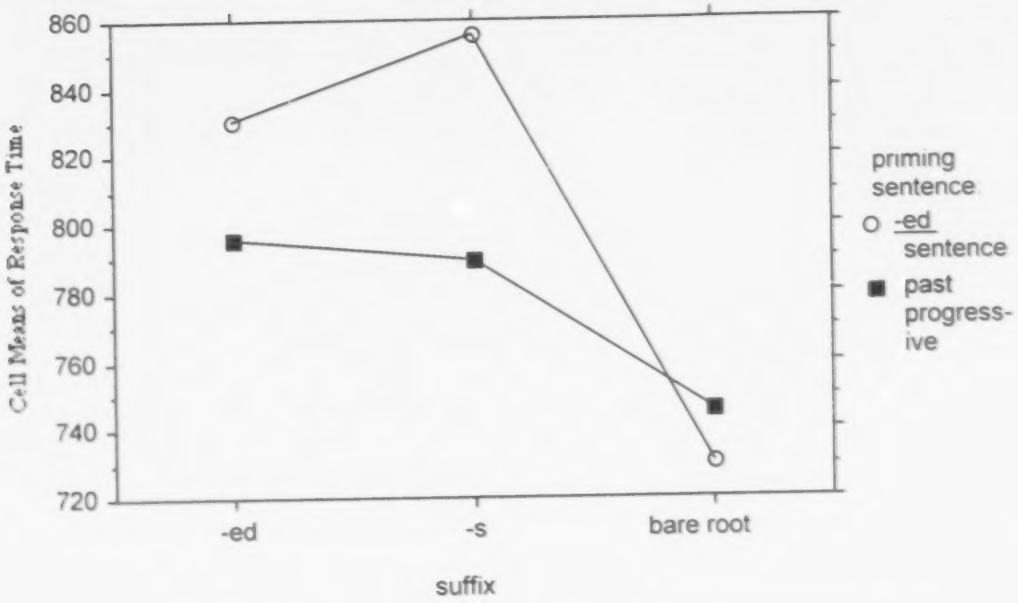

Figure 3. Interaction graph (priming sentence type by target word form)

It is difficult to interpret the results with complete confidence beyond acknowledging the two main effects and the interaction. Common post-hoc analyses are "not appropriate to compare the means of within subject factors" (Gagnon, et al. 1993: 213).

The comparison of greatest interest in connection with our original hypothesis is between the response times to the three verb types (*-ed*, *-s*, bare root) verbs in the *-ed* sentence condition, where we predicted that the response times to *-ed* forms would be faster than the response time to *-s* forms or bare roots. Therefore, *t*-tests were performed comparing the *-ed* verb response timed with the response times for each of the other two verb types.[14] The difference between response times to *-ed* verbs and to bare roots in the *-ed* sentence condition was 99.9 ms ($t[13]=3.06$, $p=.0092$). Unfortunately for the hypothesis, however, this difference was in the wrong direction, with the response time to bare roots being faster than response times to *-ed* forms. The difference between the response times to *-ed* verbs and the response times to *-s* words in the *-ed* sentence condition was 25.74 ms which was clearly nonsignificant ($t[13]=.87$, $p=.39$).

Another comparison of some interest is between the response times to inflected verbs (whether *-ed* verbs or *-s* verbs) in the progressive sentence condition and response times to bare roots in the progressive sentence condition. The difference between those two means is 47.22 ms ($t[13]=2.01$, $p=.066$) approaches significance.

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[14] A *t*-test is typically used to compare two means. It does not give a different result from ANOVA, but the latter must always be used when more than two means are being compared or when there are two or more factors. As with ANOVA, the purpose of the *t*-test is to determine the probability that a difference between two means is due to chance. If this probability is less than 5% (written $p<.05$) then the difference is considered significant in most psycholinguistic studies.

There was a difference of 35.25 ms in mean response times to *-ed* forms in the two sentence conditions, representing a nonsignificant trend (t[13]=1.46, p=.16). In the case of the *-s* inflected stems the difference between the mean reaction times two sentence conditions is 66.37 ms, which is significant (t[13]=2.75m p=.016).

In general, then, subjects responded more quickly to uninflected targets than to inflected ones although the difference was significant only in the *-ed* sentence condition. And the type of sentences subjects were listening to had a significant influence on response times to inflected forms, but had no influence on response times to bare stems.

2.5. Discussion

The hypothesis of this study was not supported. It was predicted that while listening to the spoken *-ed* sentences, subjects would respond more quickly to target words in the *-ed* form than in the *-s* form or the bare root form. This was based on Bybee's (1988, 1995) concept of the lexicon, in which there are connections between all *-ed* verbs. In this experiment it turned out that there was a clear advantage in responses to bare stems. However, the main cause of this effect appears to be revealed by the interaction: responses to inflected stems were affected by the auditorily presented sentences while responses to bare stems were not, at least not obviously affected by those sentences.

Interestingly enough, Stanners, et al. (1979) did not find a significant difference in response times to English regularly inflected verbs as opposed to bare root forms (though they did find a significant difference when bare root forms were compared with *irregularly* inflected forms). Combining the Stanners, et al. results with our own, we might well conclude that it is the aurally presented sentences that are causing the increase in processing time for inflected words, but not for bare stems. This effect of the aurally presented sentences would obscure any advantage of *-ed* verbs that might be caused by spreading activation in a Bybeean lexicon. Therefore, to get at the original question adequately it would be necessary to use a standard lexical decision task without the auditorily presented sentences.

It appears, then, that the presence of inflectional affixes on the lexical decision targets caused some increased processing difficulty related to the type of sentence being auditorily attended to. This extra processing difficulty of the inflected forms as over against the bare root forms appeared to express itself another way as well. Approximately 1.33% of responses to individual trials showed extreme response times in the sense of being more than three standard deviations beyond the particular subject's mean response time. These were well distributed among the subjects and items (only one subject had two extreme response times, while ten had a single extreme response times, and none had more than two; no single item caused an extreme response time more than once). Of the 12 response times in this category, two are in response to bare roots and the remainder are in response to inflected forms (seven to *-s* forms, three to *-ed* forms). A similar pattern is observed in relation to erroneous responses. Of the 27 that occurred (approximately 3% of the trials) five involved responses to bare roots and 22 involved responses to inflected forms (15 *-ed*, 7 *-s*). If we group the extreme response times and erroneous responses as *problematic responses* we find that of the 39 problematic responses, seven are responses to bare root forms, while 32 are responses to inflected forms. An equal distribution would have 26

problematic responses for inflected forms and 13 for bare roots. The observed distribution differs significantly from this: $\chi^2(1) = 4.15$, $p = .0415$.[15]

Although the question of whether *-ed* verbs can prime other *-ed* verbs must remain in abeyance at this point, we obviously need to address the question of why the sentence type affects the processing difficulty of inflected verb targets. To get at this, I suggest we cease thinking of sentence types in terms of simple past tense (*-ed* sentences) vs. progressive aspect (progressive sentences). In fact, this tense/aspect distinction reflects a fundamental discourse distinction. A sentence such as *The doctor delivered the baby, paddled its behind and listened to it holler* presents a chain of events, while a sentence such as *Just before dawn the soldiers were nervously guarding the entrance to the palace* provides a setting in which events can occur. Now when subjects were auditorily processing either of these two types of discourse, it appears that they were able to treat visually presented bare roots as simple isolated words, in line with the instructions they had been given. This is consistent with the proposal of Günther 1988 that a base form is the form used when naming a word. Thus an English verb root was simply the name of a verb, having no relationship to the discourse. But when inflection is added, it may be that it is no longer easy to treat the visually presented verb as simply the name of a verb. Morrow (1986) has proposed that the function of grammatical morphemes, including inflectional affixes, is to "organize objects and actions into situations". That is, the inflectional morphemes can be thought of as instructions to perform specific types of discourse integrations. For example, the simple past tense *-ed might* trigger the incrementation of the event line, while the progressive aspect might create the expectation of an event.

Morrow's (1986) proposal thus points the way toward an account of the extra processing our subjects appeared to engage in when responding to inflected forms as opposed to uninflected roots. As suggested above, they might have been able to treat the bare roots as isolated words, unrelated to the sentences they were listening to, in line with the instructions they had been given. But suppose that inflectional affixes do indeed trigger automatic discourse integration processes. The subjects were indeed engaging in discourse model-construction as they were suddenly forced to process the inflected verbs. Being confronted with an inflected verb while processing discourse would, by this reasoning, trigger at least some effort at further discourse integration. Hence the extra processing time.

To be concrete, if while hearing a sentence such as *The doctor delivered the baby, paddled its behind and listened (*) to it holler* the subjects are presented with a new *-ed* verb (e.g. *hopped*) at the point indicated by the asterisk, then even though they do not intend to relate the verb to the narrative they are listening to, the inflectional ending may trigger an automatic attempt to do so. If the verb is inflected with the *-s* suffix (e.g., *works*) the situation is perhaps not radically different, since this inflection is also used to mark events in discourse, a usage referred to as the historical present.

The fact that subjects were able to respond more quickly to inflected verbs when the auditory sentence was a progressive sentence might well be related to the fact that the progressive discourse, since it is giving the setting for an event, and thus creating the expectation of an event,

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[15]The χ^2 test is a statistical test for determining whether the distribution of items into categories is likely to be due to chance alone. In the present case, the probability is less than 5% ($p=.0415$) that problematic responses were randomly distributed among the inflected forms and bare root forms. Rather, it appears that the presence of inflection caused an increase in problematic responses.

would more readily accept an new event sentence then the *-ed* discourse, where the conjunction *and* before the third verb *listened* would lead the listener to assume that this event chain is now complete, making the sudden new event more of a surprise.

3. Conclusion

In summary, responses to inflected verbs appear to be affected by discourse processing factors, while responses to uninflected verbs do not appear to be. This suggests that uninflected v discourse types on vario erbs can readily be treated as an isolated word, in line with Günther's (1988) proposal that the base form is the form used as the name of the word. Inflections, on the other hand,demand action. They trigger discourse integrative processes in line with the proposal of Morrow (1986).

If this reasoning is on the right track, then the present findings suggest a new paradigm for exploring the functions of inflectional affixes and other grammatical morphemes in on-line discourse processing. The cross-modal paradigm could be used to examine the effects of various us inflectional affixes and other grammatical morphemes. Thus the findings of this study open new areas of research, despite the fact that the hypothesis which inspired the present experiment cannot be explored using this paradigm.

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